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THE AMOUNT AND NATURE OF TEACHER HELP NECESSARY FOR OPTIMUM ACHIEVEMENT THROUGH USE OF PROGRAMED LEARNING DEVICES.

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FOUR DIFFERENT TEACHER ROLES RANGING FROM MONITORING A PROGRAMED LEARNING SESSION TO SUPPLEMENTING THE PROGRAM BY REVIEWING BASIC CONCEPTS WERE CREATED TO DETERMINE THEIR EFFECT ON ACHIEVEMENT. A FIFTH TEACHER USED CONVENTIONAL INSTRUCTION. SUBJECTS WERE GRADE 9 ALGEBRA STUDENTS, DIVIDED INTO TWO SETS OF FIVE CLASSES EACH TO STUDY MATHEMATICS SET THEORY FOR 25 MINUTES EACH DAY. MEAN SCORES AND DISPERSIONS OF SCORES WERE COMPARED FOR EACH GROUP, AND STATISTICS USED INCLUDED BOTH ANALYSES OF VARIANCE AND COVARIANCE. IN ONLY ONE OF THE SETS OF CLASSES DID ONE CLASS ACHIEVE AT A LEVEL SIGNIFICANTLY HIGHER THAN ANY OF THE OTHER CLASSES. THE TEACHER ROLE IN THIS CLASS WAS SUPPLEMENTATION OF THE PROGRAM. APPARENTLY THE SYSTEMATIC NATURE OF THIS ROLE EFFECTED THE HIGHER ACHIEVEMENT IN ONE SET THAN IN THE OTHER. ALSO IN 1 SET, DISPERSION OF SCORES ON THE ACHIEVEMENT TEST VARIED DIRECTLY WITH THE AMOUNT OF TEACHING HELP GIVEN. TEACHER OPINIONNAIRE ANALYSIS SUGGESTED THAT A NEGATIVE TEACHER ATTITUDE TOWARD PROGRAMED LEARNING MIGHT BE REFLECTED IN RELATIVELY LOW STUDENT ACHIEVEMENT. ANOTHER COMPARISON INDICATED THAT THE PROGRAMS RESULTED IN SUBSTANTIAL SAVING OF TEACHER TIME, WITH NO ACHIEVEMENT LOSS. PROGRAMED LEARNING ACHIEVEMENT CORRELATED POSITIVELY WITH PREVIOUS ALGEBRA ACHIEVEMENT. (LH)

TEACHER HELP AND PROGRAMED LEARNING

Louis Bruno State Superintendent of Public Instruction Olympia

THE AMOUNT AND NATURE OF TEACHER HELP NECESSARY FOR OPTIMUM ACHIEVEMENT THROUGH USE OF PROGRAMED LEARNING DEVICES

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Research Report No. 05-01

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The Columbia Basin School Study Council is due special thanks for their excellent cooperation in this study. Participating school districts included:

Moses Lake	Connell
Othello	Soap Lake
Warden	Ephrata

Sincere appreciation is also expressed to all teachers and administrators from these districts for their time, effort and most cooperative attitude in this research effort.

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This contract research study was made possible by an appropriation for educational research by the 1961 Washington State Legislature.

Ray E. Jongeward
Director of Research
Office of Superintendent of Public Instruction
Olympia, Washington

December 1962

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WASHINGTON STATE UNIVERSITY
Pullman, Washington

College of Education

December 20, 1962

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Mr. Louis Bruno
Superintendent of Public Instruction
Olympia, Washington

Dear Mr. Bruno:

The College of Education at Washington State University has conducted a number of studies in the area of programed learning. We have been particularly concerned with the role of the teacher in the application of these new media for the improvement of instruction.

The schools of the Columbia Basin Research Council, in cooperation with Dr. Herbert Hite, have just completed the study which was made possible by a grant from your office concerning the role of the teacher in programed learning. The results of this study are enclosed.

We believe that the assistance obtained through your office was invaluable in our pursuit of knowledge about this matter. We believe that an understanding of the role of the teacher in using programed learning devices will be important for the improvement of instruction in the schools of the state of Washington.

The grant provided, not only made possible this specific study, but was also a stimulus for what we trust will be a rewarding association of cooperating schools, College of Education at Washington State University and your office. We hope that further cooperative studies can be conducted towards the improvement of instruction in the schools of the state of Washington. We are indeed grateful for the grant and the assistance of your office.

Respectfully yours,

/s/ Zeno B. Katterle

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SUMMARY REPORT: The Amount and Nature of Teacher Help Necessary for Optimum Achievement Through Use of Programed Learning Devices

Background of Study

In 1954, B. F. Skinner published, "The Science of Learning and the Art of Teaching." Since that time an amazing burst of activity has taken place in the study and application of Skinner's ideas concerning what has come to be known as programed learning. Educators have been motivated by the fact that programed learning may be a practical means for applying to the classroom learning principles which have been proven with animals in the learning laboratories. Researchers in psychology and education have been intrigued by the possibilities of experimentation in which the teaching variables for the first time can be controlled in a practical manner. Engineers have been stimulated to devise mechanical devices and computer-based instructional systems. Within a period of approximately five years, 122 programs were published in a variety of subject fields. The practical educator, however, had few guidelines by which he could implement the instruction of pupils through programed learning.

Research on programed learning has been concerned with three types of problem--(1) factors concerning the programs themselves (size of step, multiple choice or constructed answer, etc.), (2) characteristics of learners (differences in academic achievement, ages, etc.), and (3)

variations in methods of pupil responses to programs (by-passing, branching, linear, etc.). Although these problems are stimulating subjects for research, they have not resulted in much guidance to the classroom teacher. The research study which is reported in the following pages was an attempt to provide some information as to how programed learning devices could be administered effectively to students in the usual classroom situation. The particular variable which was analyzed was the role of the teacher.

Programed learning materials provide the stimuli for learning and also reinforce the students' responses. Therefore, the question arises, what then is the role of the teacher? If the program teaches, in the traditional sense, what is the teacher to do? The following study was designed to determine if quite different teacher roles made a difference in terms of the achievement of students working with programed learning materials. A related question is whether or not students can learn from a program if a competent teacher is not available.

In the Fall of 1961, the Columbia Basin Administrators' Study Council agreed to cooperate with the College of Education at Washington State University to study the role of the teacher for optimum learning with programed learning materials. A grant from the research funds of the State Superintendent of Public Instruction, Louis Bruno, made it possible to pursue the study. Several school districts of the Columbia Basin contributed teaching time and classroom teaching facilities for the experiments.

Experimental Procedures

The design of the experiment was that five classrooms of ninth grade algebra students would study mathematics set theory for twenty-five minutes per day during the regular algebra period. Four of the classes utilized a program published by Science Research Associates, Modern

Mathematics--Book 2. The fifth class taught by a teacher used lesson plans which paralleled the SRA program. Each of the four classes using the program was under the direction of a teacher acting in a different teaching role. Class I was taught by a teacher who served merely as a monitor--seeing that order was maintained and that students followed instructions as they studied with the programs, but offering no help on the mathematics material. Class II was under the direction of a teacher who also gave no help on mathematics, but who indicated an interest in the material and the method by completing the program during the same time as the students. Class III was taught by a teacher who offered assistance by answering such questions as individual students raised as they worked through the program. Class IV learned by completing the program and also by having the teacher review each day basic concepts covered in the program. Class V was taught by the teacher who prepared lesson plans which paralleled the program and who utilized a lecture-recitation approach for a comparable twenty-five minute period each day until the subject had been covered.

Two sets of five ninth-grade algebra classes participated in the study. One group of five classes were members of two Moses Lake junior high schools. The second group consisted of one class from each of five different school districts--Othello, Warden, Connell, Soap Lake, and Ephrata. Throughout the report, results are recorded as obtained either from the "Moses Lake group" or the "Basin group."

In March of 1962, before spring vacation, the research staff met with participating teachers and principals to explain the experiment and go over procedures. The teachers who would teach the parallel lesson plans were selected because they had attended mathematics institutes for teachers, and because they were willing to undertake the additional

preparation entailed. The two teachers with this assignment were given lesson plan materials which followed the programs exactly and which had been prepared by the research staff. Students in both experiments--the five groups in Moses Lake and the five in the Basin--were given an achievement test in algebra as a basis for judging the equivalence of the groups in mathematics. The groups learning by means of programs were permitted to work at their own pace, except that each was limited to a learning session of twenty-five minutes per day. In the program groups, each student, when he completed the program, was allowed a class session to review what he had learned. After the review period, he was given an achievement test covering the material presented in the program. The same achievement test was given the non-program groups at the conclusion of their study of set theory. This test is termed "final test" in the report of results which follows.

After the experimental teaching period, each class resumed its study of algebra. During the last week of the semester, all groups were given a different form of the achievement test on Modern Mathematics as a posttest.

The achievement of the different groups was judged on the bases of group mean scores and standard deviations of scores on the "final test." The same measures were used to compare results on the "posttests." Groups were also compared as to the time required to complete the program or to cover the lesson plans. A questionnaire concerning various aspects of administering programs to students was given to the participation teachers.

Individual scores on the final tests were correlated with individual scores on the algebra achievement test. One question in the minds of the research staff was whether or not programed learning was closely related to achievement through other forms of academic learning. By computing

these correlations for each group separately, the research staff hoped to determine whether or not differences among groups on the final test applied to all levels of academic ability.

Limitations

1. As usual in experiments with classroom groups, a major limitation was that there was no way to control variables among teachers other than those which were part of the experimental design. Variables of this kind which may have affected results were: Differences in teacher attitudes toward programed learning; differences in knowledge of the subject matter of the experiment (set theory); differences in philosophy of education, particularly regarding the importance of academic achievement in mathematics; differences in general preparation for teaching mathematics.

2. Another limitation of the study was the impossibility of controlling certain factors in the learning environment such as the time of day for the mathematics class, interpersonal relationships of pupils within the experimental classes, learning habits acquired by the students in the different classrooms up to the time of the experiment--late spring.

3. There is some question in the minds of the research staff as to the relevance of the algebra achievement test for testing equivalence of groups. The content tested in the algebra test did not appear to be very similar to that of the program. It was the most appropriate test available, however. (This was also an advantage in that previous knowledge of pupils as to set theory was practically zero.)

4. The two group 4's were given more time to master the content than the other groups. It was therefore difficult to determine whether it was the additional time or the different method which accounted for differences.

5. There was no way to control incidental learning by students outside of class, although teachers reported that they found no evidence that such learning occurred.

Results of the Study

The programed text, Modern Mathematics--Book 2, was chosen for use in this study. An important reason for this choice was the fact that the subject matter covered in the program had not been taught to the students who were to be subjects of the experiments, at least to the knowledge of the cooperating teachers. To be sure that previous knowledge on the part of the subjects, obtained from sources unknown to the teachers, would not be a factor in the study, the staff prepared and administered a 20-item multiple-choice test over the subject matter to be covered in the program. Students in the classes who were to participate in the experiments were given the test shortly before the study was to begin.

Each of the items consisted of four possible choices of an answer. Purely on the basis of chance, a student might be expected to guess correctly one time out of four. There were 20 items on the tests, so a score of five correct could be expected purely on the basis of chance. Table 1 reports the means of the ten classes on this pretest over the experimental subject matter. The Table also shows the average deviations of each group from the chance mean, 5.00. None of these deviations was significant.

Pretest on Algebra Achievement

The research staff used the Cooperative Algebra Achievement Test as a measure of the extent to which the classes were equal to each other in their ability to perform on the experimental programs. It was assumed that the ability to achieve in the usual algebra subject matter was

TABLE 1

GROUP MEAN SCORES ON MODERN MATHEMATICS PRETEST AND DEVIATIONS FROM CHANCE MEANS

Group	Mean Score	x
	Moses Lake Experiment	
1_m	5.29	+ .29
2_m	5.00	.00
3_m	4.97	- .03
4_m	4.88	- .12
5_m	5.04	+ .04
	Basin Experiment	
1_b	5.38	+ .38
2_b	5.00	.00
3_b	5.52	+ .52
4_b	4.65	- .35
5_b	5.90	+ .90

closely realted to the ability to achieve on the new subject matter used in the program--algebra set theory. Means of each group within the two experiments are reported in Table 2.

After the experimental teaching plan was completed and all students in the study had been given the final test over the experimental subject matter, the research staff correlated scores on this final test with scores obtained on the algebra pretest. This correlation was calculated to determine whether or not achievement in the usual algebra subject matter was in fact closely related to achievement in algebra set theory. Table 3 shows the correlation for each group on the two tests--algebra achievement and the final test over the programed material.

All correlations are positive and higher than .50 with the exception of group 3_b among the Basin schools. These correlations are considered to represent a significant degree of relationship between algebra achievement and achievement on the program material.

Correlations of I.Q. with Achievement on the Program Content

Final test scores on the experimental subject matter were correlated also with available intelligence quotient scores. The I.Q. scores were obtained from the cumulative record folders of individual students in the study. I.Q. scores were not available for all students, and different tests had been used to obtain these scores. The correlations reported in Table 3 are thus only approximate tendencies, rather than precise measures of the groups in the study. Groups 1, 2 and 3 in the two experiments at Moses Lake and the Basin schools are combined for comparison purposes, the two group 4's are combined, as are the group 5's. The thinking behind this procedure was that the first three groups in each experiment were all utilizing the programed text as their primary method for learning,

TABLE 2

MEAN SCORES OF GROUPS ON THE ALGEBRA ACHIEVEMENT TEST

Group	Mean Scores
Moses Lake Experiment	
1_m	25.24
2_m	25.60
3_m	21.00
4_m	20.6
5_m	21.4
Basin Experiment	
1_b	23.1
2_b	17.7
3_b	19.1
4_b	17.2
5_b	19.7

TABLE 3

CORRELATION OF INDIVIDUAL STUDENTS' SCORES ON THE ALGEBRA AND FINAL TEST

Group	r
Moses Lake Experiment	
1_m	.85
2_m	.75
3_m	.84
4_m	.57
5_m	.58
Basin Experiment	
1_b	.53
2_b	.66
3_b	.36
4_b	.70
5_b	.63

while the other two groups could be grouped because of their similar treatments in the experiment. As the data could only be regarded as crude general measures of intelligence, this grouping procedure seemed justified.

Correlations reported in Table 4 appear to support the correlations obtained in the comparison of traditional algebra achievement and achievement on the experimental subject matter. The research staff concluded that more refined study of the relationship of intelligence and achievement on the experimental subject matter was not necessary, and probably the two criteria were interrelated. The achievement on the algebra test was then used as the criterion for judging equivalence of groups.

Some of the literature on programed learning suggests that since a student is allowed to work at his own pace through a programed text of small, easy steps, that individual differences in ability among students will not be as great a factor in achievement as under traditional learning methods. The results reported in Table 3 do not support this hypothesis, because there appears to be approximately equal correlations between intelligence and achievement regardless of the degree of dependence on the programed text.

Results on the Final Test

Since there was evidence that a relationship existed between algebra achievement and achievement on the material used in the study, differences among mean algebra scores were tested by analysis of variance to determine if these differences were great enough to affect the final scores. Table 5 indicates that significant differences among these scores were discovered.

The establishment of these differences led to the utilization of analysis of covariance to determine the degree of achievement among groups

TABLE 4

CORRELATIONS BETWEEN I.Q. AND FINAL TEST SCORES CALCULATED BY GROUPS

Group	r
V	.61
IV	.54
I, II, III	.57

TABLE 5

ANALYSIS OF VARIANCE: ALGEBRA PRETEST

Source of Variation	df	Sum of Squares	Mean Square
Among Means	9	2022.36	224.71
Within Means	250	15578.95	62.32
Total	259	1701.31	

Notes:

$$F = \frac{224.71}{62.32} = 3.60$$

F sig. at .05 = 1.98
F sig. at .01 = 2.60

relative to the achievement on the algebra tests. Table 6 presents, in addition to the mean final scores of the groups, the corrected final score as calculated by analysis of covariance. Significant differences were then determined among the ten scores. Table 6 summarizes this data.

Posttests

Approximately one week prior to the terminating of the school year, posttests covering the program material were given all groups. The average time lapse between the final test and posttest varied among groups from about two to three and one-half weeks. The percentage of forgetting for each group was then calculated. Table 7 presents the mean group scores on the posttest, and time lapse, and the percent of forgetting.

It is interesting to note that the group 5's, which were the classes not using the program, constituted the first and second highest percentages of forgetting. It should be noted that group 5 of the Moses Lake schools had less lapsed time than two out of the other three Basin groups, yet forgot more than these two groups.

Dispersion Within Groups

There is some question as to whether programed materials tend to allow students of differing abilities to achieve more nearly the same amount than do traditional classroom techniques, particularly if students working with programed materials are allowed to progress at their own rate. This characteristic of programed instruction should manifest itself in the amount of dispersion of scores in the final tests. Consequently, it was felt that variability among scores should be tested and groups compared on the basis of this variability.

Standard deviations on final scores were compared on the basis of s. * Table 8 presents the standard deviations of all groups involved in the study.

*Garrett; Statistics in Psychology and Education, p. 156--standard scores.

TABLE 6

GROUP MEANS AND CORRECTED GROUP MEAN SCORES ON FINAL TEST

Group	Mean Score	Corrected Mean Score	Group	Mean Score	Corrected Mean Score
	Moses Lake Experiment			Basin Experiment	
1_m	38.48	35.72	1_b	27.20	25.83
2_m	39.52	36.53	2_b	27.63	29.83
3_m	34.06	34.02	3_b	29.70	30.99
4_m	34.38	34.12	4_b	44.31	46.89
5_m	35.30	35.10	5_b	31.33	32.22

Notes:

Significant Differences Within Each Experiment:

Group 4_b is significantly higher at the .01 level than all other Basin groups.

There were no significant differences among Moses Lake groups.

Significant Differences Among Groups When Experiments Are Combined:

Group 4_b is significantly higher at the .01 level than all groups.

Group 2_m is significantly higher at the .01 level than 1_b and 2_b ; and significantly higher at the .05 level than group 3_b.

Group 5_m is significantly higher at the .01 level than groups 1_b and 2_b.

Group 3_m is significantly higher at the .01 level than group 1_b , and significantly higher than 2_b at the .05 level.

Group 4_m is significantly higher at the .01 level than group 1_b.

TABLE 7

POSTTEST SCORES, TIME-LAPSE BETWEEN FINAL AND POSTTEST, AND PERCENT FORGOTTEN BY STUDENTS

Group	Mean Posttest Scores	Time Lapse	% Forgotten
	Moses Lake Experiment		
1_m	34.01	21.69 days	11.6
2_m	36.94	20.6	6.5
3_m	31.47	18.7	7.6
4_m	29.56	21.52	14.8
5_m	30.07	17.85	14.8
	Basin Experiment		
1_b	23.44	22.40 days	13.8
2_b	27.64	25.81	0.00
3_b	. .	. .	. .
4_b	41.28	14.62	6.8
5_b	23.57	22.00	24.8

TABLE 8

STANDARD DEVIATIONS OF GROUP SCORES ON FINAL TEST

Group	Standard Deviation
Moses Lake Experiment	
1_m	10.51
2_m	9.96
3_m	9.47
4_m	7.35
5_m	7.89
Basin Experiment	
1_b	6.25
2_b	6.65
3_b	6.45
4_b	7.82
5_b	10.01

Notes:

Significant Differences Within Each Experiment:

There were no significant differences among the Moses Lake Groups.

Group 5_b was significantly different at the .05 level from groups 1_b, 2_b and 3_b, but was not significantly different from 4_b.

Significant Differences Among Groups When Experiments Are Combined:

Group 1_b was significantly different at the .05 level from groups 1_m and 2_m.

Group 2_b was significantly different at the .05 level from groups 1_m and 2_m.

Group 3_b was significantly different at the .05 level from groups 1_m and 2_m.

The data on standard deviations within the Basin experiment shows an apparent relationship between the amount of teacher help provided and the amount of dispersion of scores. The greater amounts of direct teacher help given in the classes in groups 4 and 5 are associated with relatively large dispersion of scores. The differences between groups 1, 2, and 3 in the Basin experiment and group 5 were all significant at the .05 level. To this extent these data substantiate the suggestion in programed learning literature that programed learning is associated with smaller dispersion of scores than learning which involves greater direction by teachers. The data obtained from the Moses Lake experiment does not support this conclusion. No differences are significant among classes in the Moses Lake study, and the tendency is the opposite from that described as characterizing the Basin experiment--classes which had greater amounts of teacher help had smaller amounts of dispersion of scores.

Time Involved in Study

The average time each group worked on the experimental subject matter is compared with the final score and teacher time involved in Table 9. In general, there seems to be little relationship between the average amount of time a group took to finish the program material, and the mean final score of that group. For example, group 1_b invested 40% less time than group 2_b, yet achieved nearly as well. Group 5 teachers invested the same amount of time that students spent on the material. The group 4 times were calculated on the conservative estimate that the teachers utilized 12 minutes each period in the process of reviewing and explaining the material that the students had covered in previous 25-minute periods with their programed texts. It is difficult to estimate the actual expenditure of teacher time in the group 3 situation, since the teacher activity was

TABLE 9

TIME SPENT BY TEACHERS AND STUDENTS AND GROUP MEAN SCORES ON FINAL TEST

Group	Mean No. Hours per Group	Mean Score Each Group	Estimated No. Hours Teachers Spent
	Moses Lake Experiment		
1_m	15.52	38.48	0.00
2_m	15.86	39.52	0.00
3_m	17.23	34.06	. .
4_m	21.39	34.28	7.00
5_m	15.30	35.30	15.30
	Basin Experiment		
1_b	12.07	27.20	0.00
2_b	20.90	27.63	0.00
3_b	21.39	29.70	. .
4_b	24.38	44.31	8.00
5_b	14.58	31.33	14.58

primarily that of answering questions students might have during their 25 minute period with the program.

Graphic Presentation of the Data

Figures 1 and 2 present in graphic form the relative achievements on the Algebra Pretest, the Final Test on the experimental subject matter, and the Posttest of each participation class. In all cases the means represented by the bar heights are derived from raw scores and are not the corrected means obtained by analysis of covariance, as described above. The relative heights of the bars representing Final Test scores and Posttest scores for any one group are not indicative of the exact amount of forgetting for that group, because there were sixty items on the fifth Final Test and only 51 on the Posttest. The significance of the graphs lies in the comparative results among different groups.

In Figure 1 the heights of the bars for the different groups follow the same pattern for all three tests. This is true in Figure 2 also, with the exception that Algebra Pretests for groups IV and I are not consistent with these patterns.

Figures 3 and 4 graphically compare not only the mean tendency of the groups on the Final Test, but also the dispersion of scores on this test for each participation class.

The Teacher Opinionnaire

The replies of the teachers to an opinionnaire provided additional data concerning the experiments.

One question in the opinionnaire dealt with the lesson plans provided the control group teachers. In response to a question as to their adequacy, both control group teachers stated that some points of the material would

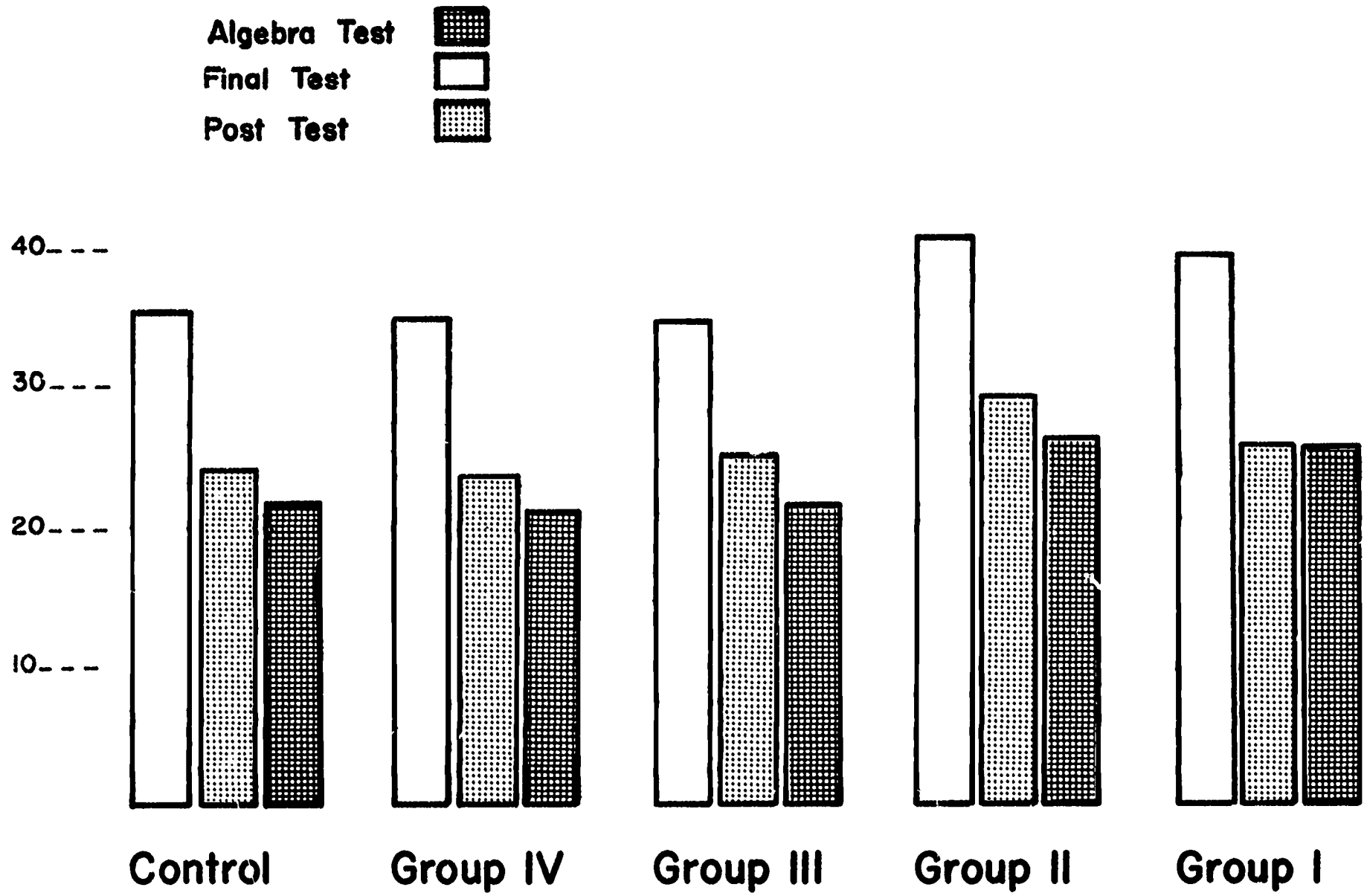

Fig. 1.--Mean Scores on the Algebra Pretest, Final Test, and Posttest of the Moses Lake Groups.

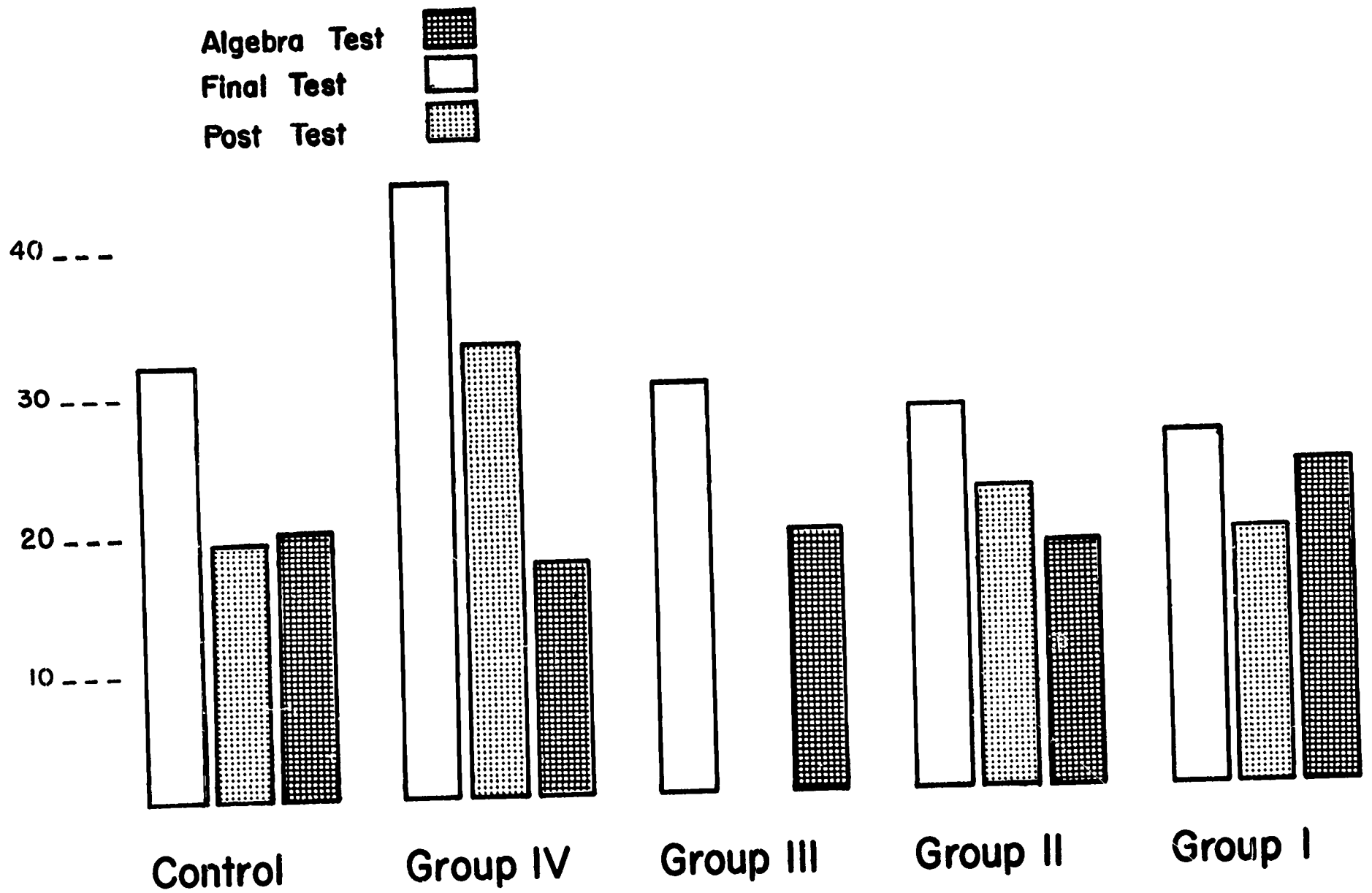

Fig. 2.-- Mean Scores on the Algebra Pretest, Final Test, and Posttest of the Basin Groups.

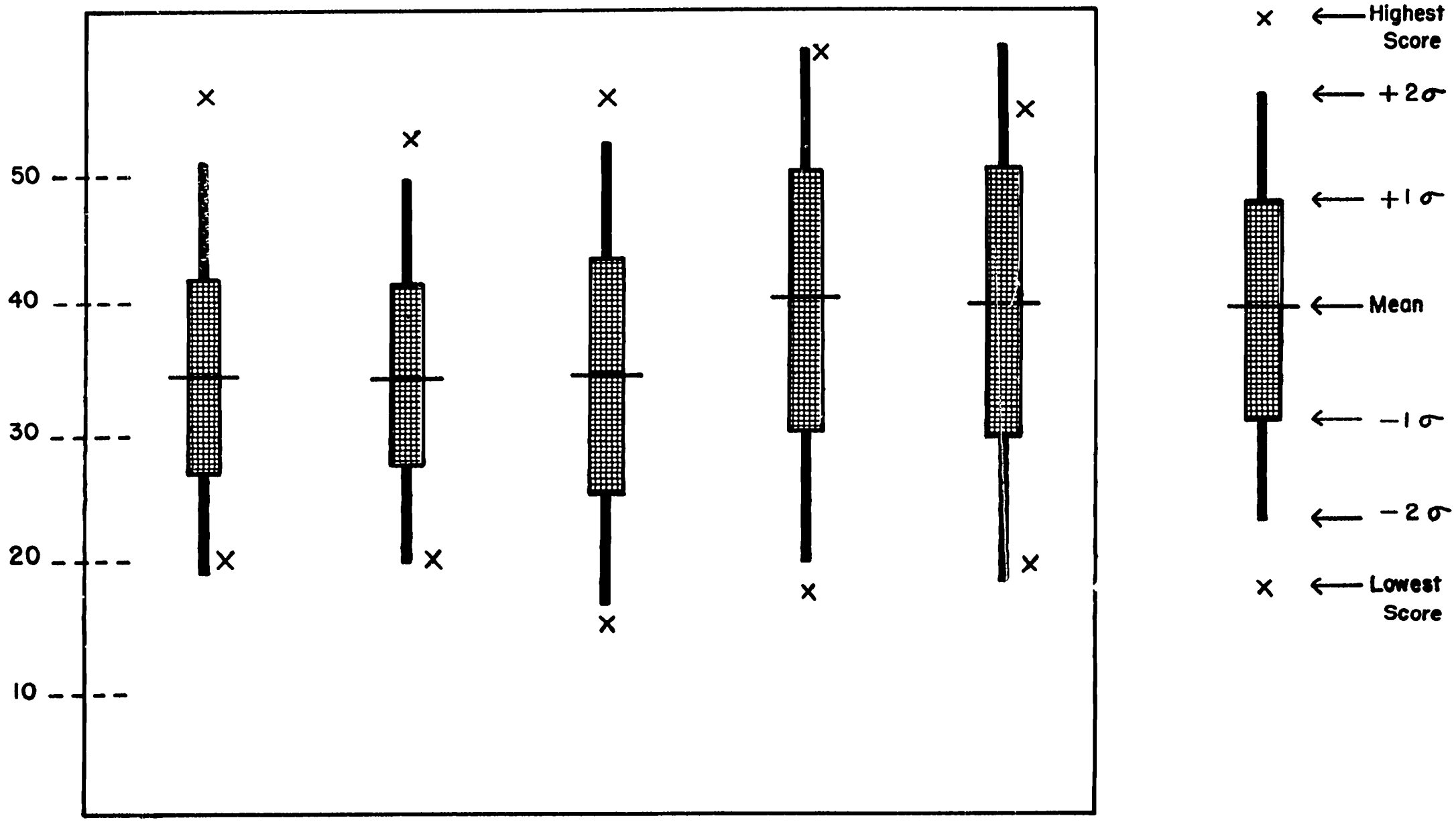

Fig. 3.--Distribution of Moses Lake Group Scores on Final Test.

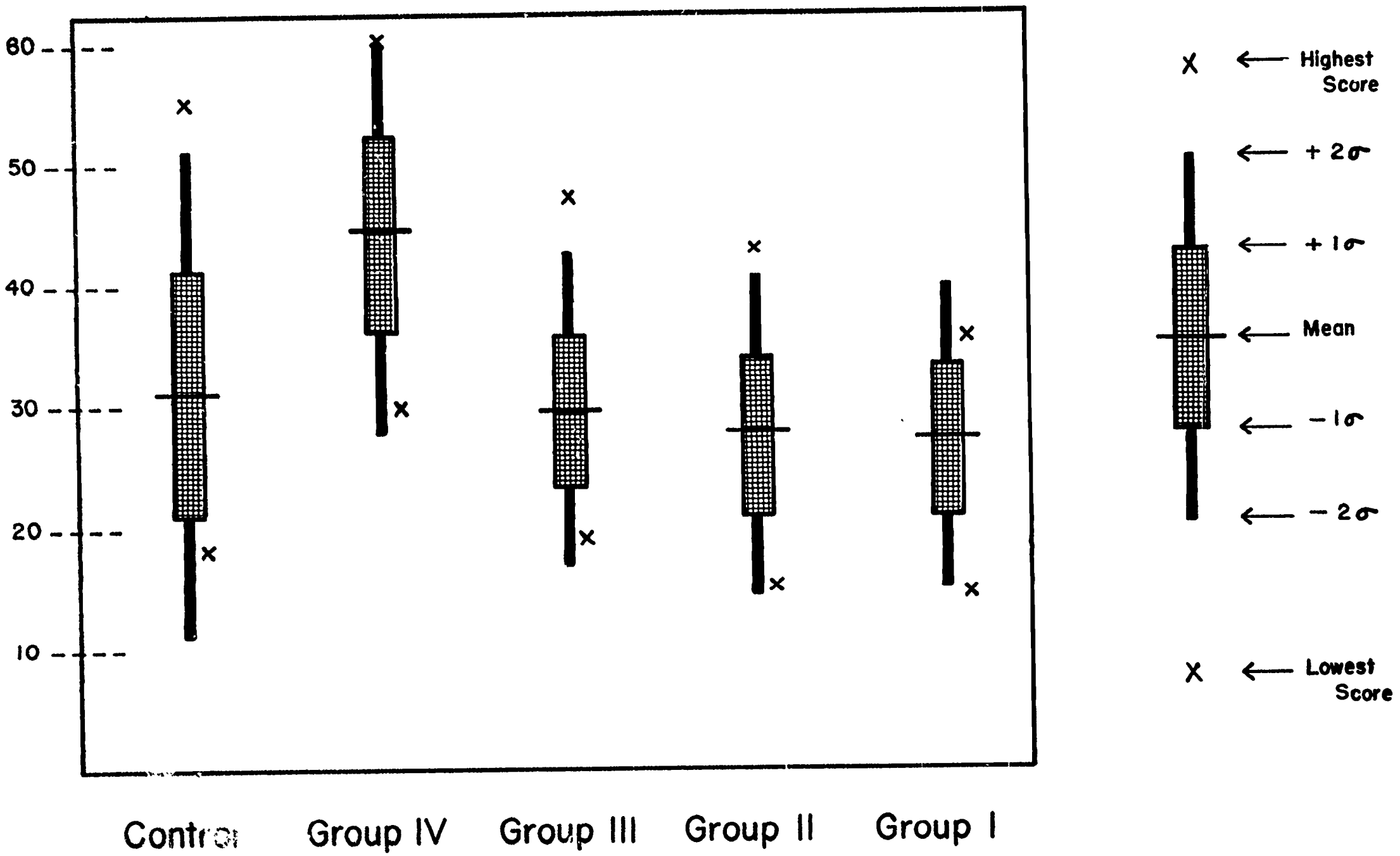

Fig. 4.--Distribution of Basin Group Scores on Final Test.

have been better understood from a text. If a text had been provided, the control groups might have achieved higher on the final test over the material than they actually scored.

This study was an attempt to determine if teacher attitude as manifested in the classroom toward programed instruction would have an influence on the student achievement on the program. This problem was studied mainly by an analysis of the roles played by the group 1 and group 2 teachers in that the group 1 teacher was to act as a monitor only, supplying no positive attitude toward the program, and the group 2 teacher was to lend psychological support to the students by actually proceeding through the program in the class session with the students. Responses to the opinionnaire revealed another attitude role present--that of a teacher not as enthusiastic about programed learning as the others. The serious doubts he expressed in the opinionnaire dealt with such areas as student interest and motivation, value of programed instruction compared with traditional procedures, and value of the use of this material as a major teaching tool. He also reported that the students cheated constantly, and that they could see little value in this type of learning. He questioned the learning theory involved, and expressed doubt that he would pursue the area of programed learning further. Most important to this study is the possibility that the opinions and attitudes of this teacher influenced his students to some degree, just as the opinions found in other teachers influenced their students. This particular group under discussion achieved the lowest of all groups involved in the study.

Generally, the teachers reported students enjoyed working with the program, but that it was the average and superior students that worked best with it. Both control group teachers stated that the "no grade" policy (no grades were given the students over material covered in the study) had

a negative influence on motivation, while all except one of the teachers using programs stated motivation was generally high despite the policy.

Competition was reported high among students using the program at the beginning of the study, but this quickly disappeared and students became less concerned with the progress of others. Additionally, program length, period length, physical facilities, level of program difficulty, and other aspects of the study were deemed appropriate by the majority of teachers.

All teachers but one felt that they would like to use programed materials in the future in their teaching, and that it was a valuable teaching tool if used in proper context. All except one were strongly in favor of this type of experimentation in the schools and expressed a desire to see it continue.

Conclusions and Implications

The experiment in Moses Lake and the experiment in the Basin schools did not agree in all respects, but it is evident that students can learn certain types of subject matter as well from a program as they can from a well-prepared teacher. The program used for this research, in common with all programs, does not include all the learning instruction which would be desirable for pupils studying modern mathematics. The program provides the knowledge, but only a teacher can guide students in appropriate uses, or applications, of this knowledge. It does appear, however, that a well-designed and tested program can relieve the teacher of routine presentation of basic facts and skills. It is equally obvious that a skillful and well-prepared teacher can present basic facts as well as a program--if he chooses to spend his time in this activity.

The study showed that it is possible to save significant amounts of teacher time without sacrificing achievement by using the program instead of the teacher to present basic mathematical concepts.

One of the group 4 classes clearly was superior to all the other groups in the experiment. The other group 4 class was not different in performance from other groups. We can reason from these two results that teaching can make a substantial improvement in the learning which results from programed instruction, but that such improvement does not result merely from the additional effort on the part of the teacher. In the group 4 classroom in which a clear superiority in mathematics achievement was attained the teacher systematically reviewed the concepts taught by the program. In the other group 4 class, the teacher used a question and answer procedure to supplement the program. Apparently the systematic instruction was advantageous and the informal recitation was not.

A flaw in experimental design developed at the stage when the posttests were administered. The experiment had to be scheduled late in the school year, with the result that too little time elapsed between the final and posttests in the cases of different experimental subjects. Students utilizing the program method worked at their own pace and some students finished considerably later than others. The result of this procedure was that some students had materially less time than others between final and posttests, with increased opportunity to remember more of the experimental subject matter. Also, some groups (for reasons which the staff cannot explain) required significantly more time than other groups to complete the program. In spite of these severe limitations, the results suggest the possibility that students forget less as a result of programed learning than from nonprogramed instruction.

Some evidence suggests that the range of achievement scores among students who learn from programs will be less than the range of other learners. The data in the comparisons of the Basin groups indicate that the range of scores increases in proportion to the amount of teacher help given. The result was not significant in the same manner when the data of the Moses Lake groups were analyzed.

The research staff arbitrarily imposes a 25-minute limitation on the programed learning sessions. This practice period proved to be about right for most students. Interest stayed at a high level until late in the experiment.

Analysis of the opinionnaires filled out by the participation teachers shows that programed learning in the form of programed textbooks is easily assimilated into present school procedures. No special physical facilities or radical revisions of teaching methods were considered necessary. The

opinionnaire indicated that a negative attitude towards programed learning on the part of the teacher may affect the achievement of the students. This suggestion from the opinionnaire analysis is not conclusive evidence of this tendency, but this finding suggests that programed learning should not be initiated over the objections of the staff.

The main implication from these results seems to be that programed learning is as effective as what may be expected from other good teaching conducted over the same time period, at least with certain kinds of subject matter. Programed learning supplemented by systematic teacher instruction can result in a significantly superior level of achievement by learners of varying academic abilities.

ABSTRACT: The Amount and Nature of Teacher Help Necessary For Optimum Achievement Through Use of Programed Learning Devices

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The objective of this study was to determine what effect different teacher roles would have on achievement of students using programed learning devices.

Two sets of five classrooms of ninth-grade algebra students studied mathematics set theory for 25 minutes each day during the regular algebra period. In each set, four of the classes utilized the program, Modern Mathematics--Book 2. The fifth class was taught by a teacher using lesson plans which paralleled the program. Each of the four programed learning classes was taught by a teacher acting in a different teaching role. The four teaching conditions were:

a. The teacher merely monitored the programed learning session.

b. The teacher gave no help but completed the program himself.

c. The teacher answered individual student's questions.

d. The teacher supplemented the program by reviewing basic concepts.

Student achievement in the ten different classes was compared on the basis of mean scores and dispersions of scores for each group. Statistical treatment included both analyses of variance and covariance.

In one set of five classes, no significant differences in student achievement were found. In the other set of five classes one of the experimental classes achieved at a level which was significantly higher than any

of the other classes. In this class students combined study of the program with supplementation by the teacher. The fact that this type of teacher supplementation was superior in one experimental set and not in the other led to further study of the specific procedures used by the two teachers. The research staff tentatively concluded that it was the systematic nature of the teacher supplementation which was superior.

In the procedure which was different and successful the teacher reviewed by orally summarizing each concept presented in the program in the order in which it occurred. In the other procedure, the teacher reviewed by means of answering students' questions in a class discussion.

In one set of experimental classes, dispersion of scores on the achievement test varied in direct proportion to the amount of teaching help given students. In the other set of five classes there were no significant differences in terms of dispersion, and such differences as occurred were in the opposite direction as in the other experiment.

Teachers reported no serious problems in administering the program which was in the form of a programed text. Analysis of the opinionnaires suggested the possibility that a negative teacher attitude towards programed learning might be reflected in relatively low student achievement.

A comparison of achievement and teacher time expended indicated that the programs resulted in a substantial saving in teacher time, with no loss in achievement.

Programed learning achievement correlated positively with previous achievement in algebra, suggesting that the same student characteristics associated with success under traditional academic learning conditions would be associated with success under programed learning conditions.

The research staff concluded that programed learning directed towards achievement of mathematical concepts is as effective as other forms of

instruction conducted within the same time span, and, administratively, programed learning can be used to save substantial amounts of teacher time. Programed learning supplemented by systematic teacher instruction can result in a significantly superior level of achievement.